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METHOD AND APPARATUS FOR CONFIGURING INTEGRATED CIRCUIT DEVICES

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Background of the Invention

[0001] The present invention relates to the electronics programming arts. It finds particular application in conjunction with configuring integrated circuit ("IC") devices used as controlling devices and will be described with particular reference thereto. It will be appreciated, however, that the invention is also amenable to configuring other types of IC devices.

[0002] An IC controlling device (e.g., a microprocessor device (a central processing unit ("CPU")) and/or an Application Specific Integrated Circuit ("ASIC")) requires an internal configuration to be loaded from an external source upon being reset (e.g., when power is applied). A conventional approach for providing configuration data to the controlling device involves the use of a plurality of configuration pins on the controlling device. The logical signals communicated to the various configuration pins are static. In other words, once the configuration pins are set to either a logical high or low, the logical states of the configuration pins do not change and, furthermore, the controlling device is configured.

[0003] One drawback to this conventional approach for configuring a controlling device is that because the configuration pins are hardwired, the logical signals transmitted to the respective configuration pins are static. Therefore, the number of possible configurations for the controlling device is proportional to the number of configuration pins. As such, the flexibility of the controlling device is limited. At the same time, the cost of manufacturing the controlling device is proportional to the number of pins. Consequently, conventional controlling devices that include several configuration options must include a proportional number of configuration pins and, furthermore, are relatively expensive.

[0004] Another conventional approach for providing configuration data to the controlling device involves the use of a previously configured electrically erasable programmable read only memory (EEPROM) or other data source, which is hard-wired to the controlling device. More specifically, a plurality of pins (e.g., four (4)) on the EEPROM are hard-wired to a plurality (e.g., four (4)) of configuration pins on the controlling device. Upon power-up (reset), the controlling device reads the contents (configuration data) of the EEPROM via the configuration pins.

[0005] The controlling device is typically configured by transmitting respective "high" and "low" logical signals (configuration data) from the pins on the EEPROM to the plurality of configuration pins on the controlling device. The logical signals communicated to the various configuration pins are used only for configuring that device. Configuration of a second controlling device requires a second configuration data source and has associated corresponding costs.

[0006] The present invention provides a new and useful method and system of configuring IC controlling devices that addresses the above problems.

Summary of the Invention

[0007] In one embodiment of the present invention, a method for configuring a plurality of controlling devices includes transmitting first serial configuration data from a data device to a first one of the controlling devices. Second serial configuration data is transmitted from the data device to a second one of the controlling devices.

[0008] In accordance with one aspect of the present invention, a method for transmitting configuration data to a plurality of integrated circuit devices includes receiving a first signal into a data storage device from a first of the integrated circuit devices. A first portion of the configuration data, which is associated with the first integrated circuit device, is serially transmitted from the data storage device to the first integrated circuit device as a function of the first signal. A second signal is received from a second of the integrated circuit devices into the data storage device. A second portion of the configuration data, which is associated with the second

integrated circuit device, is serially transmitted from the data storage device to the second integrated circuit device as a function of the second signal.

[0009] In accordance with another aspect of the present invention, a plurality of signals executable on a computing device, which includes a data device, a first controlling device electrically communicating with the data device, and a second controlling device electrically communicating with both the data device and the first controlling device, include configuration data signals and control signals. The configuration data signals are stored on a computer readable medium, which communicates with the data device. The control signals are generated within the first and second controlling devices for managing transmissions of the configuration data signals from the data device to the first and second controlling devices.

Brief Description of the Drawings

[0010] The invention may take form in various components and arrangements of components, and in various blocks and arrangements of blocks. The drawings are only for purposes of illustrating a preferred embodiment and are not to be construed as limiting the invention.

[0011] FIGURE 1 illustrates an exemplary overall system diagram in accordance with one embodiment of the present invention;

[0012] FIGURE 2 illustrates an exemplary schematic diagram in accordance with another embodiment of the present invention;

[0013] FIGURE 3 illustrates an exemplary schematic diagram in accordance with another embodiment of the present invention; and

[0014] FIGURE 4 illustrates an exemplary implementation methodology of configuring configurable devices in accordance with one embodiment of the present invention.

Detailed Description of the Preferred Embodiments

[0015] The following includes definitions of exemplary terms used throughout the disclosure. Both singular and plural forms of all terms fall within each meaning:

[0016] "Computing device", as used herein, includes but is not limited to a programmable machine that responds to a specific set of instructions in a well-defined manner and executes a prerecorded list of instructions (e.g., a program). The term "computer" is synonymous with "computing device."

[0017] "Integrated Circuit" ("IC"), as used herein, includes, but is not limited to a small electronic device made out of a semiconductor material. Integrated circuits are used for a variety of devices, including microprocessors, application specific integrated circuits (ASICs) and data storage devices, in, for example, audio and video equipment, and automobiles.

[0018] "Chip", as used herein, includes but is not limited to a small piece of semiconducting material (usually silicon) on which an IC is embedded. Computing devices consist of many chips placed on electronic boards called printed circuit boards. Different types of chips include, for example, CPU chips (also called microprocessors), which contain an entire processing unit, and memory chips, which store data.

[0019] "Device", as used herein, includes any machine or component that attaches to a computing device. Examples of peripheral devices, which are separate from a main computing device, include disk drives, printers, mice, and modems. Examples of integrated devices, which are incorporated into a main computing device, include central processing units and application specific integrated circuits. Most devices, whether peripheral or not, require a program called a device driver that acts as a translator, converting general commands from an application into specific commands that the device understands.

[0020] "Computer Readable Medium", as used herein, includes but is not limited to any memory device, storage device, compact disc, floppy disk, or any other medium capable of being interpreted by a computer.

[0021] "Software", as used herein, includes but is not limited to one or more computer executable instructions, routines, algorithms, modules or programs including separate applications or from dynamically linked libraries for performing functions and actions as described herein. Software may also be implemented in various forms such as a servlet, applet, stand-alone, plug-in or other type of application. Software can be maintained on various computer readable mediums as is known in the art.

[0022] "Signal", as used herein, includes but is not limited to one or more signals, a bit stream, an algorithm, a routine, a program or the like. The term "command" is synonymous with "signal."

[0023] "Network", as used herein, includes but is not limited to the internet, intranets, Wide Area Networks (WANs), Local Area Networks (LANs), and transducer links such as those using Modulator-Demodulators (modems).

[0024] Illustrated in FIGURE 1 is an exemplary overall system diagram of the present invention. A system **10** includes a computing device **12** and a device **14** (e.g., an output device). It is contemplated that the output device **14** is a printing device; however, other output devices (e.g., video devices) are also considered. Although the output device **14** is illustrated as being external to the computing device **12**, it is also contemplated to incorporate the output device **14** into the computing device **12**.

[0025] The computing device **12** includes first and second configurable devices **20, 22**, respectively (e.g., IC chips). In the embodiment illustrated, the first configurable device **20** is an application device (e.g., an ASIC), and the second configurable device **22** is a processing device (e.g., a central processing unit ("CPU")). However, other types of configurable devices are also contemplated. The computing device **12** also includes a data device **24** (e.g., a computer readable medium ("CRM")) for storing data signals. At least some of the data signals stored in the data device **24** are configuration data signals, which are transmitted to the configurable devices **20, 22** during a configuration process. A control device **26** (e.g., at least one of a power supply, voltage monitor, and any other control device) controls operation of the devices **20, 22, 24** within the computing device **12**.

[0026] Illustrated in FIGURES 2 and 3 are exemplary schematic diagrams of the computing device **12** in accordance with first and second embodiments, respectively, of the present invention. For ease of understanding the distinctions between the two (2) embodiments, like components are designated in FIGURE 3 by like numerals with a primed (') suffix while unique components are designated by distinct numerals.

[0027] Illustrated in FIGURE 4 is an exemplary implementation methodology of configuring configurable devices in accordance with the present invention. The blocks shown represent functions, actions or events performed therein. It will be appreciated that computer state machines or microcode involve dynamic and flexible processes such that the illustrated blocks can be performed in other sequences different than the one shown.

[0028] With reference to FIGURES 1-4, a process for configuring the configurable devices **20, 22** starts in a block **1010**. Configuration data is previously stored in the data device **24**. As discussed below, the configuration data is used for configuring the first and second configurable devices **20, 22**. For reasons discussed below, the configuration data is referred to as serial data.

[0029] Respective reset signals are transmitted from within the computing device **12** to the first configurable device **20** and the data device **24** in a block **1014**. It is contemplated that the reset signals be transmitted when the control device **26** powers-up the computing device **12**; alternatively, the reset signals are transmitted on-demand when a user of the system **10** issues a command, for example, to re-boot the computing device **12**. After receiving the reset signals, the first configurable device **20** and the data device **24** are enabled in a block **1016**. More specifically, reset pins **30, 32** of the first configurable device **20** and the data device **24**, respectively, communicate directly with the control device **26** via data lines **34, 36**, respectively. When the control device **26** is activated, logical signals are transmitted from the control device **26** to the reset pins **30, 32** of the first configurable device **20** and the data device **24**, respectively. The logical signals (e.g., either logical high or low signals) transmitted to the pins **30, 32** at power-up activate the respective devices **20, 24**.

[0030] Although the second configurable device **22** is controlled by the control device **26**, a reset pin **40** of the second configurable device **22** does not directly communicate with a logical output pin of the control device **26**; instead, as discussed in more detail below, the reset pin **40** communicates with a logical output pin **42** of the first configurable device **20** via a communication line **44**. Therefore, although the second configurable device **22** is powered-up along with the computing system **12**, the device **22** is neither reset nor enabled by the first configurable device **20** and the data device **24**.

[0031] Once the first configurable device **20** and the data device **24** are enabled, the first configurable device **20** generates signals (e.g., timing or control signals) transmitted, in a block **1020**, from the first configurable device **20** to the data device **24** along a communication line **46, 60** (see FIGURES 2 and 3, respectively). With reference to FIGURE 2, the communication line **46** electrically splits into **46a, 46b**. Therefore, the signals transmitted in the block **1020** are communicated along the path **46a, 46**. With reference to FIGURE 3, the communication line **60** is not electrically split and, therefore, the signals transmitted in the block **1020** are simply communicated between the devices **20', 24'** along the line **60**.

[0032] Referring again to FIGURES 1-4, once the data device **24** begins receiving the signals from the first configurable device **20**, a first portion of the configuration data is transmitted from the data device **24** to the first configurable device **20**. The first portion of the configuration data represents the configuration data associated with the first configurable device **20**.

[0033] In the embodiment illustrated in FIGURE 2, the first portion of the configuration data is transmitted from the data device **24** to the first configurable device **20** via a data line **50** as a function of the control (clock) signals transmitted along the communication line **46a, 46**. In this embodiment, the data line **50** electrically splits into data line components **50a, 50b**. Therefore, the first portion of the configuration data is transmitted to the first configurable device **20** via a path **50, 50a**.

[0034] In the embodiment illustrated in FIGURE 3, the first portion of the configuration data is transmitted from the data device **24'** to the first configurable

device **20'**, via a data line **62**, as a function of the control (clock) signals transmitted along the communication line **60**.

[0035] Referring again to FIGURES 1-4, because the data path **50, 50a; 62** (see FIGURES 2 and 3, respectively) represents only a single communication line between the first configurable device **20** and the data device **24**, the configuration data is transmitted serially. In this case, the configurable device **20** generates a signal for causing the configuration data to be transmitted serially. However, other embodiments, in which the configuration data is transmitted in parallel, are also contemplated.

[0036] With reference to FIGURES 2 and 4, because the communication line **46** electrically splits into **46a, 46b**, the data device **24** may receive signals from both the first and second configurable devices **20, 22**. Consequently, a potential exists that the signals transmitted along the communication lines **46a, 46b** could interfere with one another along the line **46**. For this reason, the first and second configurable devices **20, 22** must be controlled so that only one of the devices **20, 22** is transmitting a signal to the data device **24** at any one time. Consequently, in a block **1022**, after the first portion of the configuration data is transmitted to the first configurable device **20**, the first configurable device **20** stops transmitting the control signal to the data device **24**.

[0037] In a block **1024**, the first configurable device **20** transmits a reset signal from the output pin **42** to the reset pin **40** of the second configurable device **22**. It is contemplated that the reset signal transmitted in the block **1024** is a logical signal. Furthermore, when the computing device **12** is powered-up, an initial logical signal transmitted from the first to the second configurable devices **20, 22**, respectively, is a logical high or a logical low for disabling the second configurable device **22**. Then, in the block **1024**, a logical signal, which is opposite to the initial logical signal, is transmitted for enabling the second configurable device **22**. Once enabled, the second configurable device **22** begins transmitting, in a block **1026**, signals (e.g., control, clock, or timing signals) to the data device **24**.

[0038] With reference to FIGURES 2 and 4, the signals associated with the block **1026** are transmitted via a path **46b, 46**. Furthermore, in the block **1026**, a

second portion of the configuration data is transmitted from the data device **24** to the second configurable device **22** via a path **50, 50b** as a function of the control signals transmitted along the path **46b, 46**. Therefore, the signals and the second portion of the configuration data are transmitted to the second configurable device **22** without passing through the first configurable device **20**.

[0039] With reference to FIGURES 3 and 4, the signals associated with the block **1026** are transmitted from the second configurable device **22'** to the first configurable device **20'** via a communication line **64**; then the signals are transmitted from the first configurable device **20'** to the data device **24'** via the communication line **60**. Furthermore, in the block **1026**, the second portion of the configuration data is transmitted from the data device **24'** to the second configurable device **22'** via the first configurable device **20'**. More specifically, the second portion of the configuration data is transmitted, as a function of the signals transmitted from the first configurable device **20'** to the data device **24'**, from the data device **24'** to the first configurable device **20'** via the data line **62**; furthermore, the configuration data is then transmitted, as a function of the signals transmitted from the second configurable device **22'** to the first configurable device **20'**, from the first configurable device **20'** to the second configurable device **22'** via a data line **66**. It is to be understood that the data is at least one of stored in and passed through the configurable devices **20, 22.**

[0040] With reference again to FIGURES 1-4, the second portion of the configuration data represents the configuration data associated with the second configurable device **22**. As discussed above, although it is illustrated to transmit the configuration data serially from the data device **24** to the second configurable device **22**, it is also contemplated to transmit the configuration data in parallel.

[0041] After the second portion of the configuration data is transmitted to the second configurable device **22**, the process stops in a block **1028**.

[0042] It is to be understood the devices **20, 22** are configured for different functions. For example, it is contemplated that the ASIC **20** is configured for controlling the output device **14**. In this respect, the ASIC acts as a device driver for the output device **14**. Furthermore, it is contemplated that the CPU **22** is configured for controlling the general operations of the computing device **12**. However, the

devices **20, 22** may also be configured as an interface to other devices (e.g., memory devices, audio devices, telephonic devices, and/or network devices).

[0043] The data device **22** is contemplated to be a static device. More specifically, it is contemplated that once configuration data is stored in the device **22**, the data is retained until new configuration data is stored in the device **22**. Consequently, it is contemplated that the data device **22** is an erasable programmable read-only memory ("EPROM"). However, it is also contemplated that the data device **22** is a programmable read-only memory ("PROM"), an electric erasable programmable read-only memory ("EEPROM"), or any other static/non-static computer readable medium. Furthermore, although the devices **20, 22, 24, 26** are illustrated as including a limited number of input/output ("I/O") pins, it is to be understood other numbers of I/O pins for each of the devices **20, 22, 24, 26** are contemplated.

[0044] The invention has been described with reference to the preferred embodiment. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.